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Mathematical Skills as Predictors of Students' Performance in Secondary School Mathematics in Ogun State, Nigeria

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ABSTRACT

Stakeholders in education must understand the relationship between students' mathematical performance and their mathematical skills in order to develop a more effective mathematics curriculum and education. It is on this basis that this study examined mathematical skills as a predictor of students' performance in secondary school mathematics in Ogun State, Nigeria. The survey design used for this study was descriptive. The population of this study consisted of all Senior Secondary School Two (SSS2) students in Ogun State. Four hundred eighty (480) secondary school students from the SSS2 class comprised the study sample. In this study, simple random and purposeful sampling methods were used. Purposive sampling technique was used to select twelve (12) schools among secondary schools in Ogun State, while the simple random sampling technique was used to select forty (40) respondents from each school. For this study, two research questions were used. The instruments used for data collection are: Mathematics Performance Test (r = 0.762); Numerical Skills Test (r = 0.86); Spatial Reasoning Test (r = 0.78); and Problem-solving Style Questionnaire (r = 0.82). The results showed a significant positive relationship between mathematical skills and students' performance in mathematics. The correlation of independent variables in relation to the performance of students in mathematics is as follows: Numerical skills ($r=0.122, p<0.05$); Spatial skills ($r=0.182$, $p<0.05$); and Problem-solving skills ($r=0.139, p<0.05$) respectively. It was further revealed that mathematical skills relatively contributed to students' academic performance in mathematics. It was then concluded that mathematical skills are an important factor that enhances students' performance in mathematics.

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1. INTRODUCTION

Mathematics is a subject that is widely used and essential for people of all ages and situations. It exposes students to significant concepts, skills, and knowledge that are applicable in everyday life and across numerous disciplines [1]. Similar to how a strong foundation is essential for the stability of a house, mathematical skills are the cornerstone of more advanced capabilities. A wide range of intricate and integrated knowledge and abilities is required for the present-day mathematics classroom. Mathematics is intended to be meaningful and relevant in Nigerian secondary schools, meeting the requirements of the community as well as the skill levels of the students [2]. Lyons and Ansari [3] provided evidence that proficiency in mathematics is a crucial indicator of success in the classroom. Because mathematical skill acquisition is hierarchical, mastering core skills is essential for advancing to more advanced levels, and it is inevitable to lay a solid mathematical foundation for success in mathematics. Thus, this study examined mathematical skills as a predictor of students' performance in secondary school mathematics in Ogun State, Nigeria. In this study, three types of mathematical skills were identified: problem-solving, spatial, and numerical skills.

Mathematical studies are built on numerical skills, which are also one of the most important abilities that students need to acquire [4]. Clerkin and Gilligan [5] define numeracy as the general understanding of numbers and basic mathematical concepts. These include skills such as counting, contrasting, describing forms and places, and finding solutions in mathematics. Numeracy skills are a range of numerically oriented abilities. These include more complex mathematical processes, such as trigonometry, algebra, and geometry, as well as basic operations like addition, subtraction, multiplication, and division. Higher levels of numeracy competency are associated with a higher likelihood of success in mathematics. Poor numeracy skills could constitute a barrier to success in mathematics.

Furthermore, having low numeracy skills will make it more challenging to learn and understand mathematical topics, as well as harder to keep up with higher-level concepts. To improve students' academic performance, particularly in mathematics, parents and teachers can collaborate to ensure that pupils acquire and master numeracy skills [6]. According to Davidse et al. [7], being numerate involves having the assurance to identify numbers, count, recognize numbers, perform simple operations, and apply these skills to comprehend complex ideas. Numerical literacy also refers to the ability to apply a variety of numbers and symbols associated with fundamental mathematics to solve real-world problems in diverse settings. Additionally, it is used to evaluate data presented in various graphs, tables, and charts and to understand the analysis's findings in order to make decisions [8]. Furthermore, critical literacy in the interpretation of numerical data is also closely linked to information literacy, which is defined as the ability to locate, assess, organize, use, and convey information in all its forms, particularly when making decisions and acquiring knowledge [9].

More importantly, spatial skills are another mathematical ability that influences students' performance in mathematics. According to Seah and Horne [10], spatial skills

encompass the abilities needed for the representation, transformation, generation, and retrieval of symbolic and non-linguistic data. Spatial competence was also defined by Wai et al. [11] as the ability to create, hold, and modify coherent visual pictures. The use of images was the primary focus of both definitions above. These abilities can be viewed as a distinct form of intelligence that sets them apart from other cognitive capacities or types of intelligence, such as language, reasoning, and memory abilities. Spatial ability is composed of numerous interconnected subskills that evolve throughout a person's life. It is not a fixed attribute that allows for individual variance [12]. Our ability to mentally manipulate, arrange, analyze, and make sense of spatial relationships in both real and imagined spaces is known as spatial abilities [13]. They are frequently used for routine operations, such as moving from one place to another or installing furniture. Studies have shown that spatial abilities are flexible and may be developed with effort and experience [14]. Research investigating the connection between mathematical achievement and spatial skills reveals a considerable correlation between the two for children across all educational levels [15]. For instance, children who possess superior visuospatial working memory perform better on counting activities and number line estimation [16]. Even after considering other skills, such as verbal skills, secondary school students' mental rotation performance remains related to their mathematical reasoning abilities and their future mathematics learning [16]. Apart from the performance-based evidence of the connection between mathematical achievement and spatial skills, earlier research suggests that a positive relationship between spatial skills and mathematics achievement may be predicated on similar cognitive processes [17]. In conclusion, spatial skills can be developed through practice and experience, and they are linked to the learning and performance of mathematics. Therefore, understanding how additional factors, such as students' problem-solving skills for learning mathematics, interact with spatial skills and numerical skills to predict mathematics performance is crucial for improving students' performance in mathematics.

The ability to solve problems is a crucial life skill that involves several different processes, including interpretation, analysis, prediction, evaluation, and reasoning [6]. The process of solving problems is multifaceted and involves emotive, behavioral, and cognitive abilities. The challenges and barriers that the person faces during this process include complex tasks that need to be completed [18]. To foster the development of creative and critical thinking skills in students, non-routine problems that they may encounter in their daily lives should be included, rather than processes that can be solved using predetermined rules and formulas[19]. Through the process of solving problems, students learn how to approach challenges methodically and communicate their cognitive processes [20]. The ability of students to solve problems is a major factor in their achievement. As a result, it is a complex process for students to solve problems, as it depends on their prior knowledge, experience, education, and environmental circumstances [21].

Furthermore, research has shown that students who believe they are very good at solving problems also tend to be very confident in themselves, are not unduly scared of what happens to them, and approach problems carefully in order to come up with workable solutions [22]. Students who have a strong sense of problem-solving typically have an

easier time handling the mathematical problems they face. Stated differently, students who demonstrate proficient problem-solving abilities are adaptable and create efficient strategies to solve mathematical problems and accomplish their objectives of having good results [21]. Furthermore, students who believe they are competent at solving problems tend to engage in more problem-solving activities, devote more time to problem-solving, and generate ideas relevant to solving mathematical problems more easily [22]. Heppner [22] found that students with a poor perspective on problem-solving tend to be reluctant, apprehensive, and insecure when faced with solving mathematical problems. In contrast, students with a high perception of problem-solving are psychologically and physically stable, and they feel comfortable achieving success in solving mathematical problems.

Several theoretical frameworks have been established in recent years to account for academic achievement and skills development from various angles in educational research. Among them are models concentrating on motivational and engagement elements [1], supply-usage models [23], and skill progression patterns [23]. These theories primarily concentrate on students' learning and individual skill growth in mathematics. Brühwiler and Blatchford [23] have provided a summary of the current theoretical framework and three models of skill growth. These are as follows: 1) a cumulative model, in which students with higher ex-ante skills experience an even higher rate of skill growth; 2) a compensatory model, in which students with lower ex-ante skills catch up and exhibit a higher rate of skill growth compared to their higher ex-ante skill levels; and 3) a stable model, in which students' skill differences remain constant over time. Nigerian students' performance in mathematics continues to lag behind that of their international counterparts, despite significant efforts to improve achievement in the discipline. Studies on the relationship between spatial, numerical, and problem-solving skills and secondary school mathematics achievement have not yet been conducted. Therefore, a significant amount of research is needed to identify the causes of students' low performance in mathematics. It is on this basis that the present study examined factors such as numerical skills, spatial skills, and problem-solving skills as predictors of students' performance in secondary school mathematics in Ogun State, Nigeria.

After looking at the concept of numerical skills, spatial skills, and problem-solving skills and how these skills affect the academic performance of students in mathematics therefore, the following research questions were developed: (i) What are the relationship among numerical skills, spatial skills and problem-solving skills and students' academic performance in mathematics? (ii) What are the relative contributions of numerical skills, spatial skills, and problem-solving skills to students' academic performance in mathematics?

2. METHOD

2.1 Research design and population

A descriptive survey design had been chosen for this study. The study population consisted of all Senior Secondary School Two (SSS2) students in Ogun State.

2.2 Sample and Sampling Technique

Four hundred and eighty students from the Senior Secondary School II (SSSII) class made up the sample of the study. The study employed purposive and simple random sampling techniques. Thirty (40) respondents were chosen at random from each school, whereas twelve (12) secondary schools in Ogun State were chosen using a purposeful sampling technique.

2.3 Research instruments and procedure

Four instruments used for data collection are: the Mathematics Performance Test, the Numerical Skills Test, the Spatial Reasoning Test, and the Problem-solving Styles Questionnaire.

a. Mathematics Performance Test (MPT): The Mathematics Performance Test consists of thirty multiple-choice questions with four possible answers. The researchers developed a mathematics performance test to assess students' mathematical abilities. The questions chosen were from the Senior School Certificate Examinations organized by the West African Examination Council (WAEC) and the National Examination Council (NECO). The knowledge, understanding, and application levels are all tested on the Mathematics Performance Test (MPT). A thorough analysis was conducted to determine the suitability and accuracy of MPT's validity and reliability. A table of specifications was created to confirm the dependability of the content. The original eighty (80) items of the objective question were administered to sixty (60) students who were not included in the sample selected by the researchers. Item analysis was done using the students' responses. The results of the analysis were used to choose items (a fixed difficulty index ranging from 40% to 60%) that positively differentiate between strong and weak students. A sample of fifty SSS2 students who were not included in the main study were given the thirty-item MPT. The test-retest reliability technique, with a coefficient of 0.762, was used to evaluate the dependability of the Mathematics Performance Test. The score range is 1 to 30.

b. **Numerical Skills Test (NST):** This instrument is composed of a 30-item multiple-choice test. NST measured students' number sense, mathematical thinking, statistics, mental mathematics, estimations, geometry, algebraic thinking, and calculations. Copies of the instrument were administered to thirty (30) students who were not part of the sample. The test-retest method was used to determine its reliability, yielding a reliability coefficient of 0.86.

c. **Spatial Reasoning Test (SRT):** This instrument, developed by Kozhevnikov and Hegarty (2001), is used to measure students’ spatial ability skills. SRT consisted of twenty (20) items, which were divided into four sections, namely: Metal rotation-five items, spatial visualization-five items, spatial reasoning-five items, and combined spatial reasoning-five items, respectively. The test was scored by counting the number of correct responses, with a maximum score of 20. The reliability coefficient of SRT is measured to be 0.78 using the Cronbach Alpha method.

d. **Problem-solving Style Questionnaire (PSSQ):** This questionnaire was adapted from Heppner & Baker (1997). It measures students' ability to approach problems in a logical, analytical, and systematic way. The items on PSSQ are structured on a five-point Likert scale, ranging from Strongly Agreed (SA) with 5 points, to Agreed (A) with 4 points, Neutral (N) with 3 points, Disagreed (D) with 2 points, and Strongly Disagreed (SD) with 1 point for the positive statement. The initial item on PSSQ was forty (40) with a reliability coefficient of 0.78 before modification. After some modifications to suit the purpose of this study, the adapted PSSQ consists of thirty-six (36) items with a reliability coefficient of 0.82. The score ranges from 36 to 180.

Multiple Regression Analysis and Pearson Product-Moment Correlation were used to analyze the data. During the administration of the instruments, 480 copies were distributed to randomly selected respondents, who completed the forms on the same day they were received. A 99.6% return rate was achieved since only 478 copies were recovered at the point of recovery.

3. RESULTS AND DISCUSSION

3.1. Result

Research question one: What is the relationship between numerical skills, spatial skills, problem-solving skills, and students' academic performance in mathematics?

Table 1. Correlation Matrix of numerical skills, spatial skills, problem-solving skills, and students' academic performance in mathematics

Correlation				
	Performance	Numerical skill	Spatial skill	Problem-solving skills
Performance	1			
Numerical skill	.122**	1		
spatial skill	.182**	.883**	1	
problem-solving skill	.139**	.724**	.908**	1

According to Table 1, all the considered mathematical skills (numerical skills, spatial skills, and problem-solving skills) are positively correlated with the performance of students in mathematics. The correlation of independent variables in relation to the performance of students in mathematics is as follows: Numerical skills $(r = 0.122, p < 0.05)$; Spatial skills $(r = 0.182, p < 0.05)$; and Problem-solving skills $(r = 0.139, p < 0.05)$ respectively. This result suggests that mathematical skills are essential for student performance in mathematics.

Research question two: What are the relative contributions of numerical skills, spatial skills, and problem-solving skills to students' academic performance in mathematics?

Table 2. Regression of numerical skills, spatial skills, and problem-solving skills on students' academic performance in mathematics

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	631.588	3	210.529	6.741	.000[b]
Residual	14802.855	474	31.230		
Total	15434.444	477			

*** Significance of F at α = .05**

a. Dependent Variable: performance of students in mathematics

b. Predictors: (Constant): Numerical skills, spatial skills, and problem-solving skills

Table 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.202[a]	.041	.035	5.588

Table 4. Contribution of each of the predictor variables to the performance of students in Mathematics

Model	Unstandardized coefficients		Standardized Coefficients	T	Sig
	B	Std.Error	Beta		
(Constant)	22.417	1.087		20.619	.000
Numerical skill	.147	.105	.115	1.403	.016
Spatial skill	.482	.151	.431	3.188	.002
Problem-solving skill	.162	.104	.168	1.552	.012

The regression of the combined independent variable (Numerical skills, spatial skills, and problem-solving skills) on students' mathematics performance is shown in Table 2. The result shows a significant outcome ($F = 6.741, p < 0.05$). This suggests that the independent variables of Numerical skills, spatial skills, and problem-solving skills strongly influenced the variation in the students' mathematics performance. Additionally, the result in Table 3 displays an R-squared value of 0.202 and a multiple correlation coefficient of 0.444, indicating that the independent variables —numerical skills, spatial skills, and problem-solving skills — contributed 20.2% of the variance in the dependent variable, which is students' performance in mathematics. Additionally, Table 5 displays the relative contributions of each independent variable together with the magnitude of each contribution to the dependent variable in ascending order: Problem-solving skill $(-.162)$, Numerical skill $(-.147)$, and Spatial skill$(.482)$ respectively. The equation for the regression model of student performance in mathematics is MP = K + aD + bE + cF, where MP represents mathematics performance, K is the constant of prediction (B values), D is Numerical skills, E is Spatial skills, and F is problem-solving skills, respectively. Regression model MA = 22.417 – 0.147a + 0.482b - 0.162c.

3.2. Discussion

The findings revealed a positive relationship between mathematical skills and students' performance in mathematics. It is clear from this positive relationship that students with good mathematical skills are better able to reason rationally and abstractly, solve problems, apply mathematical methods and algorithms, and explain mathematical

concepts than those with poor mental ability. This outcome is consistent with Laging and Voßkamp's findings [24], which show that students' performance in high school is greatly influenced by their mathematical abilities. The results also support the finding of Reuhkala [13], which indicated that mathematical skills were a good predictor of students' achievement in mathematics. Additionally, the results showed that student performance in mathematics and numerical ability were positively correlated. This positive relationship can be attributed to the fact that numerical skills provide students with a foundation to understand mathematical concepts and relationships, build and apply mathematical models, reason quantitatively, solve problems, and communicate mathematical ideas effectively. The result of this finding is in agreement with the findings of Guhl [25], which established a moderate correlation between the degree of numeracy skills and students' performance in mathematics. The result of this finding also revealed a positive relationship between spatial skills and students' performance in mathematics. This finding is consistent with that of Casey et al. [15], who investigated the relationship between mathematical achievement and spatial skills and discovered a strong correlation between the two for students in secondary schools. Similarly, spatial skills are essential for comprehending scientific concepts, such as physics and engineering, as well as mathematical concepts, like geometry [16]. Findings from Casey et al. [15] longitudinal research show a favorable correlation between mathematical performance and spatial skills. This finding also revealed a positive relationship between problem-solving skills and students' performance in mathematics. Students who possess problem-solving skills are better able to link mathematical ideas and apply their knowledge to actual-life situations. This result aligns with the findings of Ozenc and Carkit [26], who also discovered a significant positive correlation between the mathematics performance of fourth-grade pupils and their problem-solving skills. The ability to solve problems is a fundamental skill that all students should possess, as it is crucial in both everyday life and mathematics classes. Likely, students who excel at solving mathematical problems would also be confident and composed when handling difficulties encountered in their everyday lives. Moreover, Kaplan et al. [27] found a strong correlation between students' overall academic success and their ability to solve problems.

Nevertheless, in contrast to this study, earlier research by Stephanou and Oikonomou [28] found no evidence of a substantial correlation between students' academic achievement and their ability to solve problems. Similarly, Ozcakir and Calisici [29] found no evidence of a connection between students' mathematics academic achievement and the ability to solve problems. The findings of this study also revealed that mathematical skills relatively contributed to students' academic performance in mathematics. This result suggests that mathematical skills have a strong and significant impact on students' performance in mathematics. This result confirms Lyons and Ansari's assertion [3] that mathematical skills are an essential requirement for academic success in mathematics.

4. CONCLUSION AND RECOMMENDATION

This study examined mathematical skills as a predictor of students' performance in secondary school mathematics in Ogun State, Nigeria. The findings reveal a strong positive relationship between mathematical skills (numerical skills, spatial skills, and problem-

solving skills) and students' performance in mathematics. Additionally, the findings revealed that mathematical skills contributed relatively to students' academic performance in mathematics. The findings suggest that students with strong numerical, spatial, and problem-solving skills tend to perform better in mathematics. The implication of this study highlights the importance of developing students' mathematical skills to improve their performance in mathematics. Therefore, educators and policymakers should prioritize the development of mathematical skills in curriculum design and instructional strategies.

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REFERENCES

[1] E. R. Kahu, "Framing student engagement in higher education," *Studies in Higher Education*, vol. 38, no. 5, pp. 758–773, Jun. 2013, doi: 10.1080/03075079.2011.598505.

[2] T. O. Abiodun, O. O. Aderibigbe, I. S. Adebola, and A. A. Ayoola, "Effects of Heuristic Problem-Solving strategies on students' achievement and retention in Mathematics in Ogun State, Nigeria," *Journal of Science and Mathematics Letters*, vol. 12, no. 1, pp. 1–7, Jan. 2024, doi: 10.37134/jsml.vol12.1.1.2024.

[3] I. M. Lyons and D. Ansari, "Foundations of Children's Numerical and Mathematical Skills," 2015, pp. 93–116. doi: 10.1016/bs.acdb.2014.11.003.

[4] M. M. A. Balala, S. Areepattamannil, and D. Cairns, "Investigating the associations of early numeracy activities and skills with mathematics dispositions, engagement, and achievement among fourth graders in the United Arab Emirates," *Large Scale Assess Educ*, vol. 9, no. 1, p. 13, Dec. 2021, doi: 10.1186/s40536-021-00106-4.

[5] A. Clerkin and K. Gilligan, "Pre-school numeracy play as a predictor of children's attitudes towards mathematics at age 10," *Journal of Early Childhood Research*, vol. 16, no. 3, pp. 319–334, Sep. 2018, doi: 10.1177/1476718X18762238.

[6] S. Pitogo and R. Oco, "Pupils' Numeracy Skills and Mathematics Performance," vol. 6, pp. 333–340, Aug. 2023.

[7] N. J. Davidse, M. T. De Jong, and A. G. Bus, "Explaining common variance shared by early numeracy and literacy," *Read Writ*, vol. 27, no. 4, pp. 631–648, Apr. 2014, doi: 10.1007/s11145-013-9465-0.

[8] T. R. Hayati and K. Kamid, "Analysis of Mathematical Literacy Processes in High School Students," *International Journal of Trends in Mathematics Education Research*, vol. 2, no. 3, pp. 116–119, Oct. 2019, doi: 10.33122/ijtmer.v2i3.70.

[9] K. Stacey, "The PISA View of Mathematical Literacy in Indonesia," *Journal on Mathematics Education*, vol. 2, no. 2, Jul. 2011, doi: 10.22342/jme.2.2.746.95-126.

[10] R. T. K. Seah and M. Horne, "The influence of spatial reasoning on analysing about measurement situations," *Mathematics Education Research Journal*, vol. 32, no. 2, pp. 365–386, Jun. 2020, doi: 10.1007/s13394-020-00327-w.

[11] J. Wai, D. Lubinski, and C. P. Benbow, "Spatial ability for STEM domains: Aligning over 50 years of cumulative psychological knowledge solidifies its importance.," *J Educ Psychol*, vol. 101, no. 4, pp. 817–835, Nov. 2009, doi: 10.1037/a0016127.

[12] S. M. Patahuddin, S. Rokhmah, and A. Ramful, "What does teaching of spatial visualisation skills incur: an exploration through the visualise-predict-check heuristic," *Mathematics Education Research Journal*, vol. 32, no. 2, pp. 307–329, Jun. 2020, doi: 10.1007/s13394-020-00321-2.

[13] M. Reuhkala, "Mathematical Skills in Ninth-graders: Relationship with visuo-spatial abilities and working memory," *Educ Psychol (Lond)*, vol. 21, no. 4, pp. 387–399, Dec. 2001, doi: 10.1080/01443410120090786.

[14] D. I. Miller and D. F. Halpern, "Can spatial training improve long-term outcomes for gifted STEM undergraduates?," *Learn Individ Differ*, vol. 26, pp. 141–152, Aug. 2013, doi: 10.1016/j.lindif.2012.03.012.

[15] M. B. Casey, R. L. Nuttall, and E. Pezaris, "Spatial-Mechanical Reasoning Skills versus Mathematics Self-Confidence as Mediators of Gender Differences on Mathematics Subtests Using Cross-National Gender-Based Items," *J Res Math Educ*, vol. 32, no. 1, p. 28, Jan. 2001, doi: 10.2307/749620.

[16] C. M. Ganley and M. Vasilyeva, "Sex differences in the relation between math performance, spatial skills, and attitudes," *J Appl Dev Psychol*, vol. 32, no. 4, pp. 235–242, Jul. 2011, doi: 10.1016/j.appdev.2011.04.001.

[17] S. L. Beilock and E. A. Maloney, "Math Anxiety," *Policy Insights Behav Brain Sci*, vol. 2, no. 1, pp. 4–12, Oct. 2015, doi: 10.1177/2372732215601438.

[18] P. P. Heppner, "Expanding the conceptualization and measurement of applied problem solving and coping: From stages to dimensions to the almost forgotten cultural context.," *American Psychologist*, vol. 63, no. 8, pp. 805–816, Nov. 2008, doi: 10.1037/0003-066X.63.8.805.

[19] N. H. Lee, D. J. S. Yeo, and S. E. Hong, "A metacognitive-based instruction for Primary Four students to approach non-routine mathematical word problems," *ZDM*, vol. 46, no. 3, pp. 465–480, Jul. 2014, doi: 10.1007/s11858-014-0599-6.

[20] S. Han and H. M. Kim, "Components of Mathematical Problem Solving Competence and Mediation Effects of Instructional Strategies for Mathematical Modeling," *TED EĞİTİM VE BİLİM*, Apr. 2020, doi: 10.15390/EB.2020.7386.

[21] E. M. D. Apostol, "Problem Solving Heuristics on Non-Routine Problems of College Students," *Am J Educ Res*, vol. 5, no. 3, pp. 338–343, 2017, doi: 10.12691/education-5-3-16.

[22] P. P. Heppner, T. E. Witty, and W. A. Dixon, "Problem-Solving Appraisal and Human Adjustment," *Couns Psychol*, vol. 32, no. 3, pp. 344–428, May 2004, doi: 10.1177/0011000003262793.

[23] C. Brühwiler and P. Blatchford, "Effects of class size and adaptive teaching competency on classroom processes and academic outcome," *Learn Instr*, vol. 21, no. 1, pp. 95–108, Feb. 2011, doi: 10.1016/j.learninstruc.2009.11.004.

[24] A. Laging and R. Voßkamp, "Determinants of Maths Performance of First-Year Business Administration and Economics Students," *International Journal of Research in Undergraduate Mathematics Education*, vol. 3, no. 1, pp. 108–142, Apr. 2017, doi: 10.1007/s40753-016-0048-8.

[25] P. Guhl, "The Impact of Early Math and Numeracy Skills on Academic Achievement in Elementary School ," Northwestern College, Iowa , 2019.

[26] M. ÖZENÇ and C. ÇARKIT, "The relationship between functional literacy and problem-solving skills: A study on 4th-grade students," *Participatory Educational Research*, vol. 8, no. 3, pp. 372–384, Aug. 2021, doi: 10.17275/per.21.71.8.3.

[27] A. KAPLAN, M. DURAN, and G. BAŞ, "Ortaokul Öğrencilerinin Matematiksel Üstbiliş Farkındalıkları İle Problem Çözme Beceri Algıları Arasındaki İlişkinin Yapısal Eşitlik Modeliyle İncelenmesi," *İnönü Üniversitesi Eğitim Fakültesi Dergisi*, vol. 17, no. 1, Jan. 2016, doi: 10.17679/iuefd.17119785.

[28] G. Stephanou and A. Oikonomou, "Teacher Emotions in Primary and Secondary Education: Effects of Self-Efficacy and Collective-Efficacy, and Problem-Solving Appraisal as a Moderating Mechanism," *Psychology*, vol. 09, no. 04, pp. 820–875, 2018, doi: 10.4236/psych.2018.94053.

[29] Ö. Ö. Sümen and H. Çalışıcı, "The Relationships Between Preservice Teachers' Mathematical Literacy Self Efficacy Beliefs, Metacognitive Awareness And Problem Solving Skills," *Participatory Educational Research*, vol. spi16, no. 2, pp. 11–19, Feb. 2016, doi: 10.17275/per.16.spi.2.2.